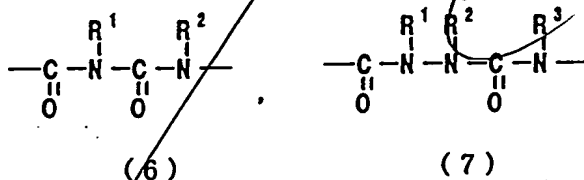
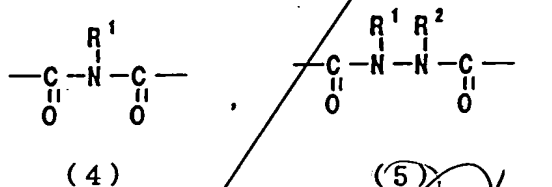
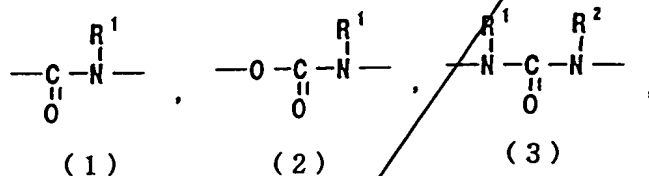


Claims

Claim 1.

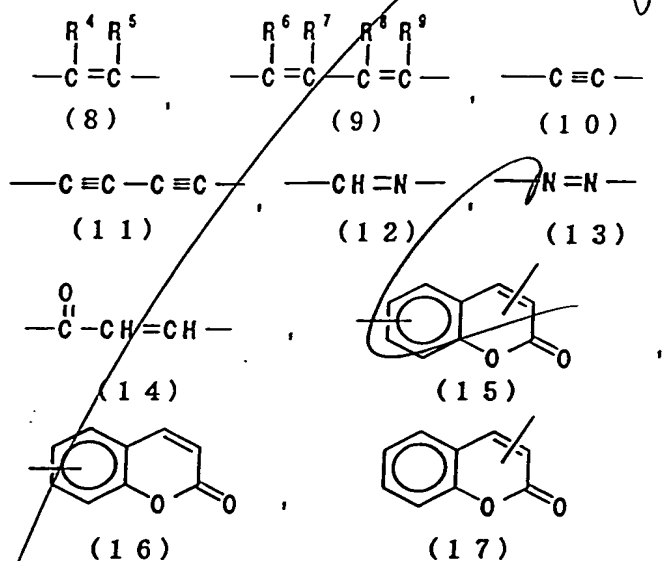
Liquid crystal alignment agent which form the liquid crystal alignment film comprising of a thin alignment film over the substrate where irradiation of light or electron rays align liquid crystal molecules without any rubbing treatment, and said liquid crystal alignment agent comprising of polymer compound having bonds shown in the general formula (1) – (7) below



wherein R¹, R² and R³ are independently of each other hydrogen, alkyl, substituted alkyl, aryl or propargyl; in the main chain of polymer compound with number-average molecular weight of 1,000 – 300,000, and said bond makes the direct bond with either divalent or trivalent aromatic group at the both ends of said bond or with divalent or trivalent aromatic group making the direct bond at one end of said bond while at the other forming the direct bond with divalent or trivalent alicyclic hydrocarbon group.

Claim 2.

Liquid crystal alignment agent according to Claim 1, where the main chain or side chain of the polymer having no functional groups shown in the general formula (8) - (17) below



what has no functional groups in side chain of polymer itself

wherein R^4 , R^5 , R^6 , R^7 , R^8 and R^9 are independently of each other hydrogen, halogen, alkyl, substituted alkyl, substituted alkoxy, carboxyl, alkoxycarbonyl or cyano group as substituent group which may lead to dimerization reaction or isomerization reaction by the irradiation with light or electron rays.

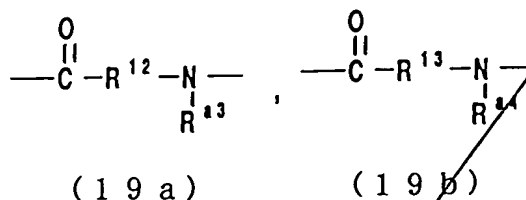
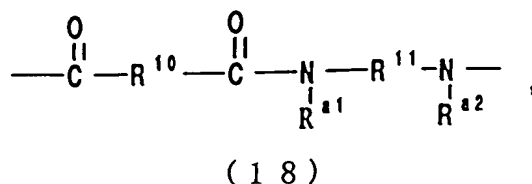
Claim 3.

Liquid crystal alignment agent according to Claim 1 or Claim 2, where said polymer is polyamide.

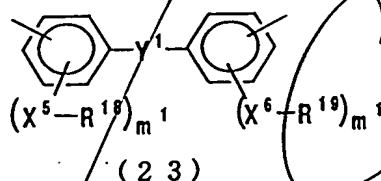
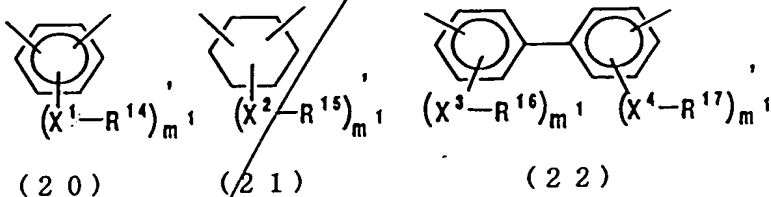
Claim 4.

Liquid crystal alignment agent according to Claim 3, where said polymer compound is polyamide having the repeating unit comprising of the general

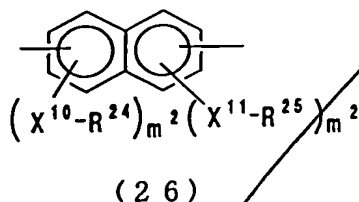
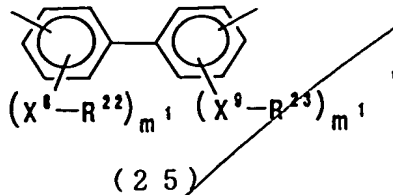
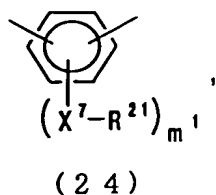
formula (18) or of the general formula (19a) and (19b) below



wherein R^{10} , R^{11} , R^{12} and R^{13} are divalent organic radical in the general formula (20) – (23)



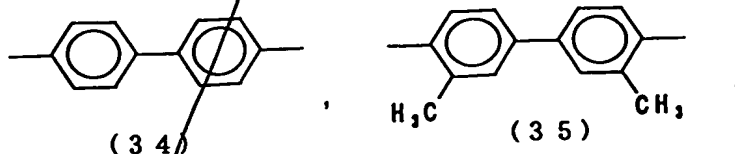
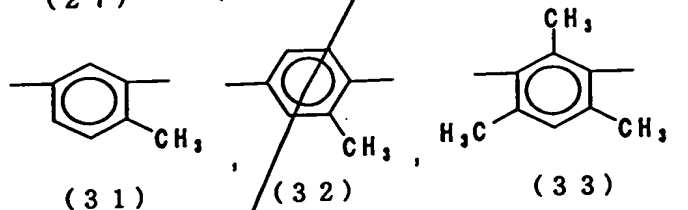
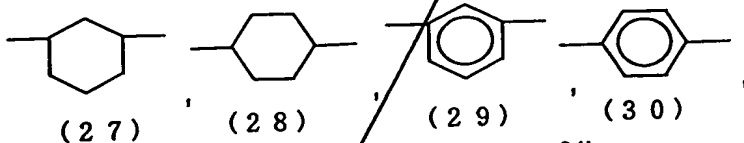
wherein X^1 , X^2 , X^3 , X^4 , X^5 and X^6 are independently of each other single bond, O, CO_2 , OCO , CH_2O , NHCO or CONH ; R^{14} , R^{15} , R^{16} , R^{17} , R^{18} and R^{19} are independently of each other hydrogen, halogen, C_1 - C_{24} alkyl, C_1 - C_{24} alkyl containing fluorine, aryl, propargyl, phenyl or substituted phenyl; Y^1 is O, S, CO, CO_2 , SO_2 , CH_2 , NH, NHCO , Y^2 - Ar^1 - Y^3 , Y^4 -(CH_2) n^1 - Y^5 or Y^6 - Ar^2 - R^{20} - Ar^3 - Y^7 ; Y^2 , Y^3 , Y^4 , Y^5 , Y^6 and Y^7 are independently of each other O, S, CO, CO_2 , SO_2 , CH_2 , NH or NHCO ; n^1 is an integer of 1-10; R^{20} is C_1 - C_5 straight or branched lower alkylene, fluoroalkylene or alkylenedioxy, and further Ar^1 , Ar^2 and Ar^3 are independently of each other divalent organic radical in general formula (24), (25) or (26) below

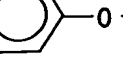


wherein X^7 , X^8 , X^9 , X^{10} and X^{11} are independently of each other single bond, O, CO_2 , OCO , CH_2O , NHCO or CONH ; R^{21} , R^{22} , R^{23} , R^{24} and R^{25} are independently of each other hydrogen, halogen, C_1 - C_{24} alkyl, C_1 - C_{24} alkyl containing fluorine, aryl, propargyl, phenyl or substituted phenyl; m^1 is an integer of 1 - 4; m^2 is an integer of 1 - 3, with the proviso that R^{14} , R^{15} , R^{16} , R^{17} , R^{18} , R^{19} , R^{21} , R^{22} , R^{23} , R^{24} and R^{25} are either hydrogen or halogen, then X^1 , X^2 , X^3 , X^4 , X^5 , X^6 , X^7 , X^8 , X^9 , X^{10} and X^{11} are single bond, and R^{a1} , R^{a2} , R^{a3} and R^{a4} are independently of each other hydrogen, alkyl, substituted alkyl, aryl or propargyl.

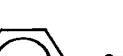
Claim 5.

Liquid crystal alignment agent according to Claim 3 or Claim 4, where R^{10} or R^{11} in the general formula (18) above or R^{12} and R^{13} in the general formula (19a) and (19b) are independently of each other radical selected from the formula (27) - (41) below

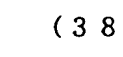




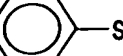
 (3 6)




 (3 7)




 (3 8)



 (3 9)



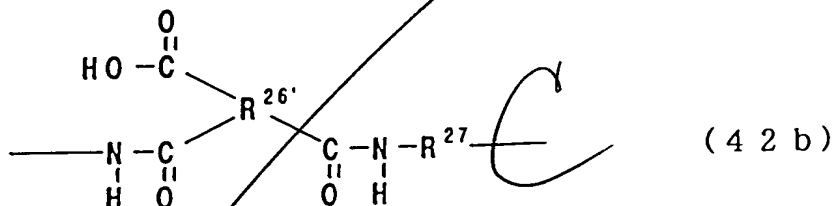
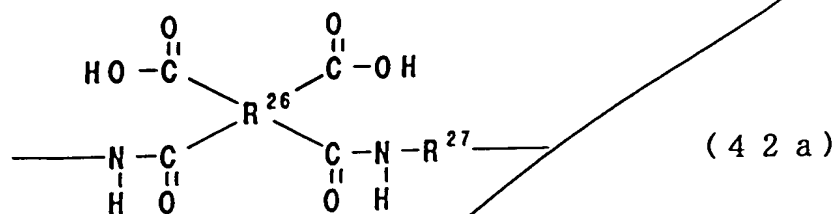
 (4 0)



 (4 1)

Liquid crystal alignment agent according to Claim 1 or Claim 2, where said polymer compound is polyimide precursor or polyimide obtained by chemical or heat imidization of said polyimide precursor.

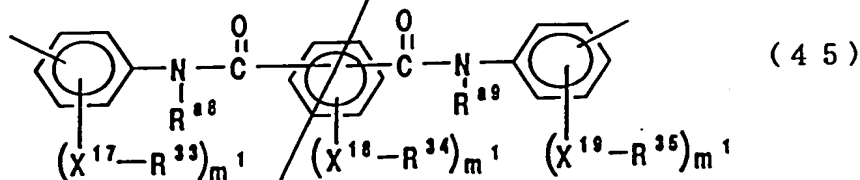
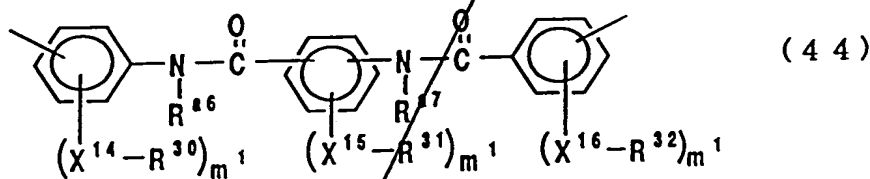
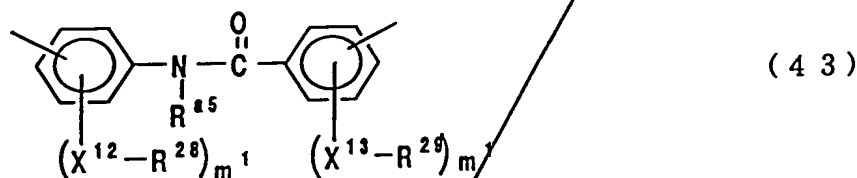
Liquid crystal alignment agent according to Claim 6 where said polymer compound is polyimide precursor or polyimide obtained by chemical or heat imidization of said polyimide precursor with the repeating unit comprising of the general formula (42a) and (42b) below



wherein R^{26} is tetravalent organic radical; $\text{R}^{26'}$ is trivalent organic radical; and R^{27} is divalent organic radical containing amide radical bonded with divalent or trivalent aromatic or alicyclic hydrocarbon group.

Claim 8.

Liquid crystal alignment agent according to Claim 6 or Claim 7, where R^{27} in the general formula (42a) and (42b) above is selected from the general formula (43) - (48) below



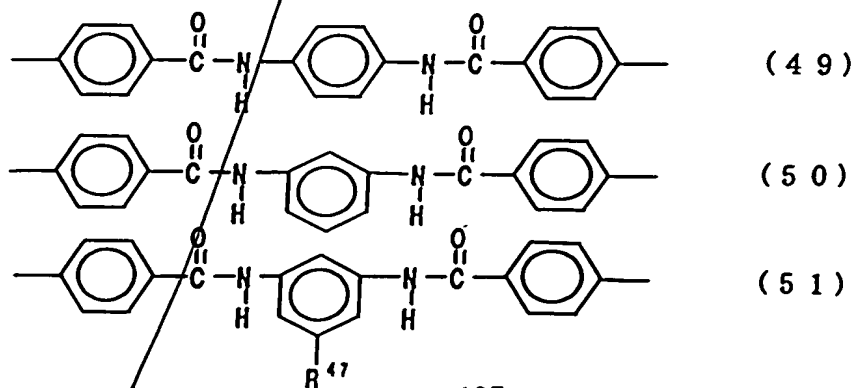
$$\begin{array}{c}
 \text{Chemical structure (46):} \\
 \text{Three repeating units connected by amide bonds. Each unit consists of a benzene ring substituted with } (X^{20}-R^{36})_m, (X^{21}-R^{37})_m, \text{ and } (X^{22}-R^{38})_m \text{ respectively. The amide groups are } -C(=O)-N(R^{a10}), -C(=O)-N(R^{a11}), \text{ and } -C(=O)-N(R^{a12}). \\
 (46)
 \end{array}$$

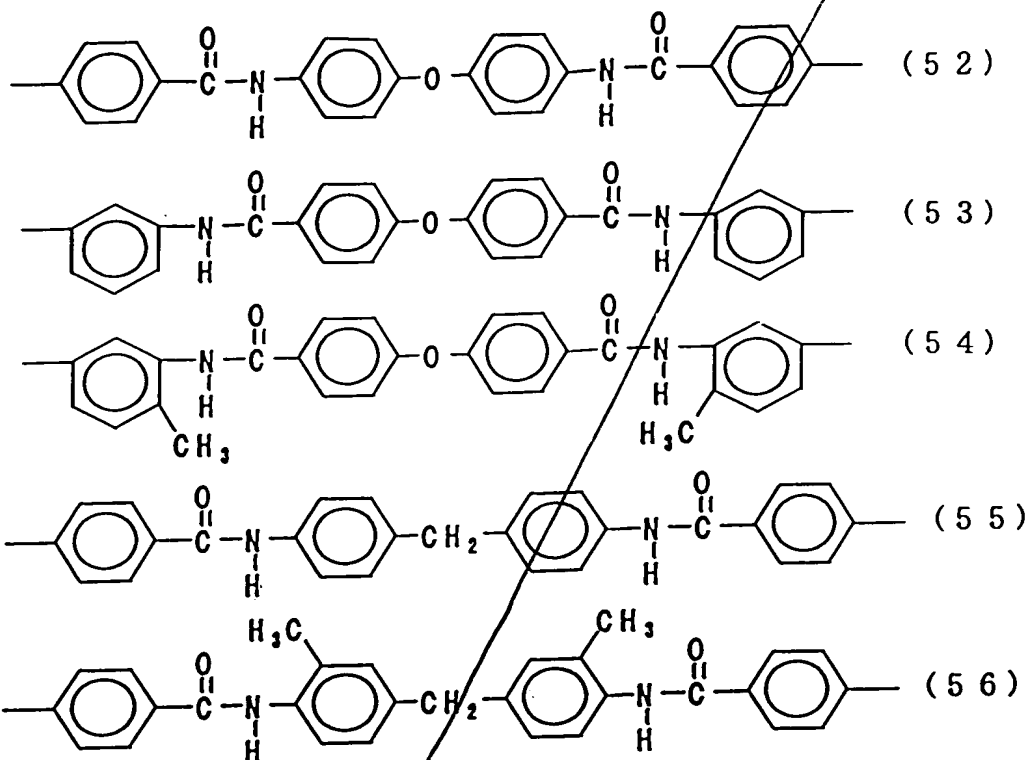
$$\begin{array}{c}
 \text{Chemical structure (47):} \\
 \text{Four repeating units connected by amide bonds. The units are substituted with } (X^{23}-R^{39})_m, (X^{24}-R^{40})_m, (X^{25}-R^{41})_m, \text{ and } (X^{26}-R^{42})_m \text{ respectively. The amide groups are } -C(=O)-N(R^{a12}), -C(=O)-N(R^{a13}), \text{ and } -C(=O)-N(R^{a14}). \\
 (47)
 \end{array}$$

$$\begin{array}{c}
 \text{Chemical structure (48):} \\
 \text{Four repeating units connected by amide bonds. The units are substituted with } (X^{27}-R^{43})_m, (X^{28}-R^{44})_m, (X^{29}-R^{45})_m, \text{ and } (X^{30}-R^{46})_m \text{ respectively. The amide groups are } -C(=O)-N(R^{a14}), -C(=O)-N(R^{a15}), \text{ and } -C(=O)-N(R^{a16}). \\
 (48)
 \end{array}$$

Claim 9.

Liquid crystal alignment agent according to any one of Claim 6 through Claim 8, where radical for R²⁷ in the general formula (42a) and (42b) above is selected from in the formula (49) - (56) below





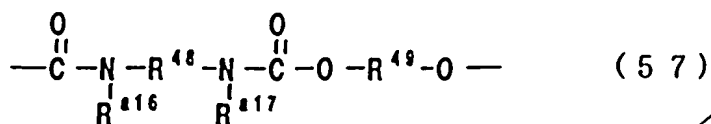
wherein R^{47} is halogen, C_1 - C_{24} alkyl, C_1 - C_{24} alkoxy or C_1 - C_{24} alkoxycarbonyl.

Claim 10.

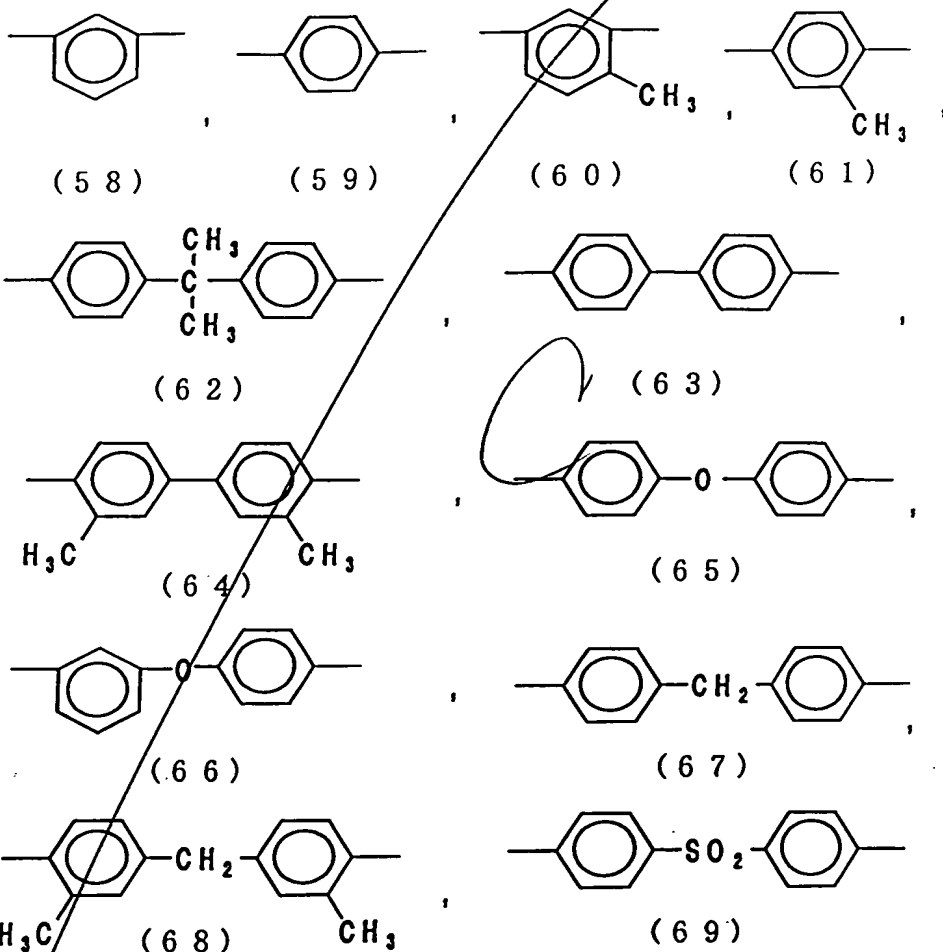
Liquid crystal alignment agent according to Claim 1 or Claim 2, where said polymer compound is polyurethane.

Claim 11.

Liquid crystal alignment agent according to Claim 10, where said polymer compound is polyurethane having the repeating unit comprising of the general formula (57) below



wherein R^{48} and R^{49} are independently of each other selected from radical shown in the formula (58) - (69) below



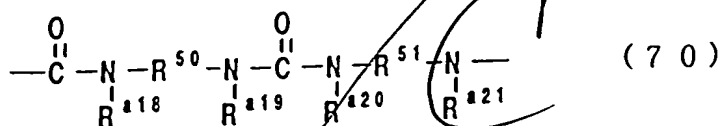
wherein R^{a16} and R^{a17} are independently of each other hydrogen, alkyl, substituted alkyl, aryl or propargyl.

Claim 12.

Liquid crystal alignment agent according to Claim 1 or Claim 2, where said polymer compound is polyurea.

Claim 13.

Liquid crystal alignment agent according to Claim 12, where said polymer compound is polyurea having the repeating unit of the general formula (70) below



wherein R^{50} and R^{51} are independently of each other selected from formula (58) - (69) above; and R^{a18} - R^{a21} are independently of each other hydrogen alkyl, substituted alkyl, aryl or propargyl.

Claim 14.

Liquid crystal device by the use of the liquid crystal alignment agent according to any one of Claim 1 through Claim 13.

Claim 15.

Alignment method of liquid crystals characterized by the use of the liquid crystal alignment agent according to any one of Claim 1 through Claim 13, where light or electron rays being irradiated over the thin polymer film formed on the surface of the substrate and achieving liquid crystal alignment without rubbing action.

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